Fig. 5. DO Concentrations at mile 2.2

(July 11 and 12, 1990)

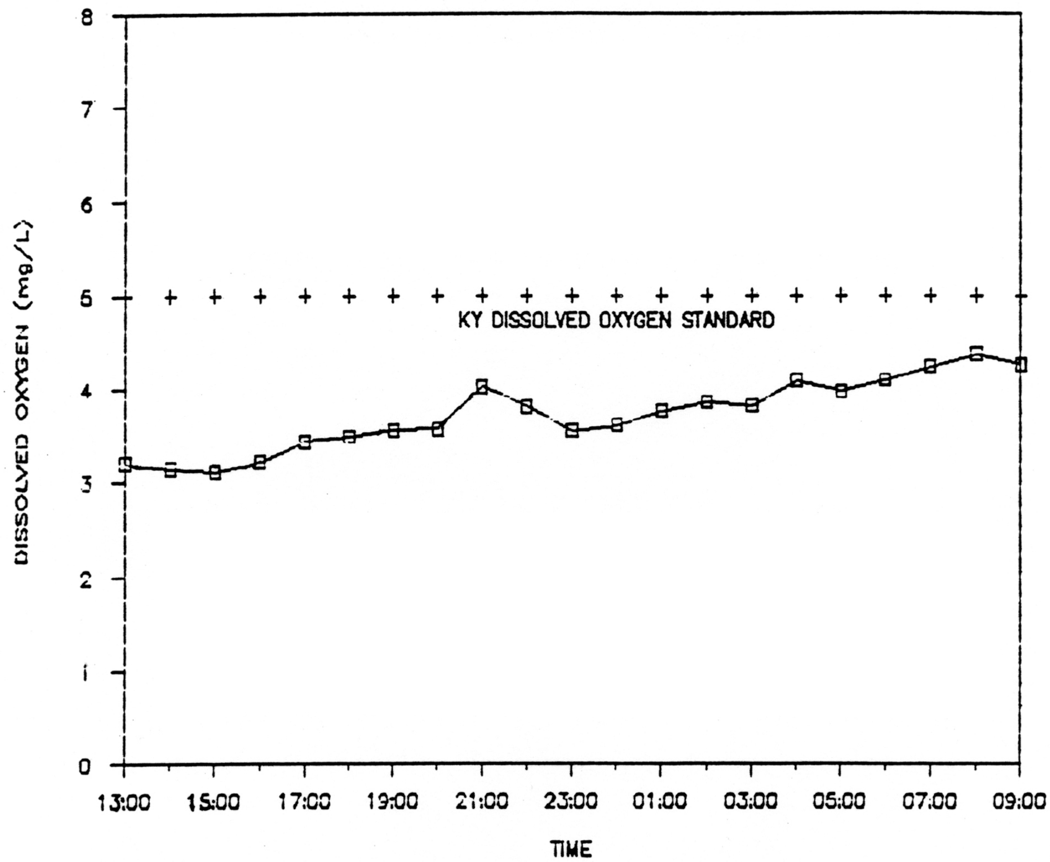
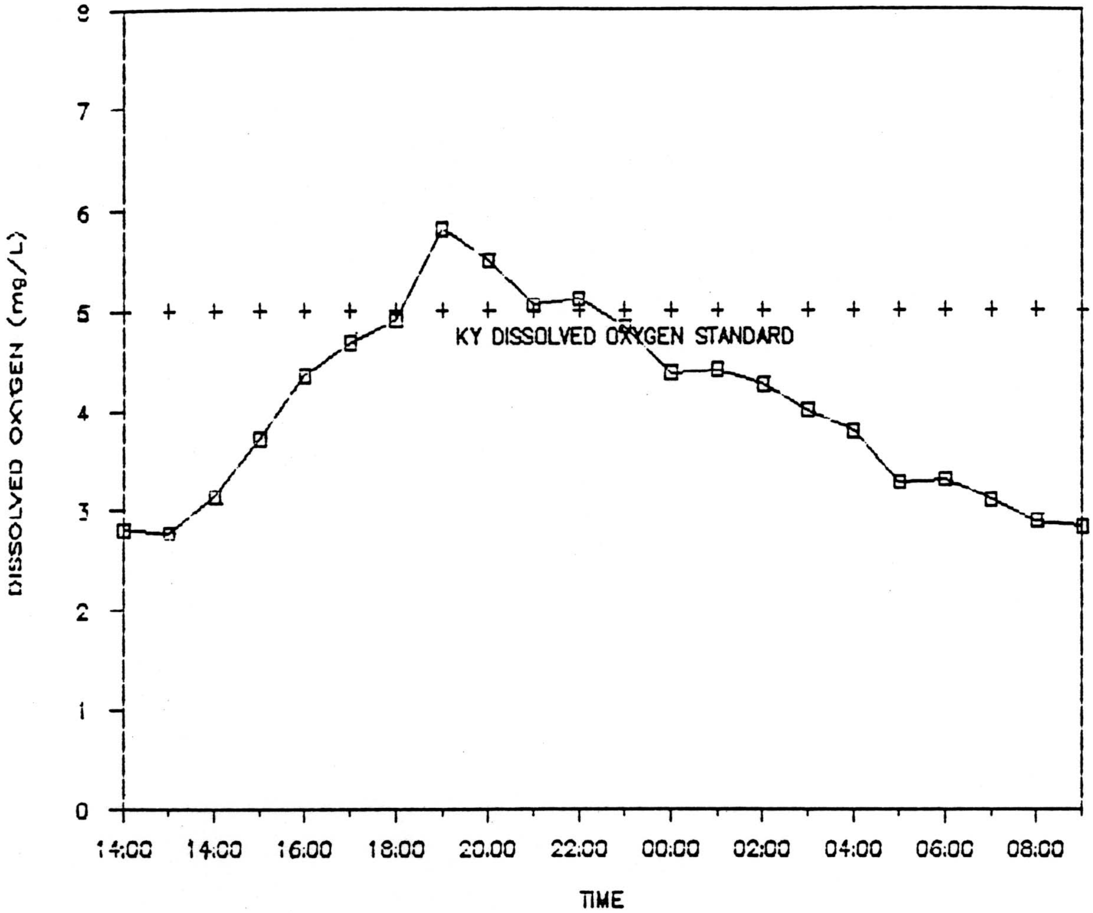


Fig. 6. DO Concentrations at mile 1.5
(July 10 and 11, 1990)

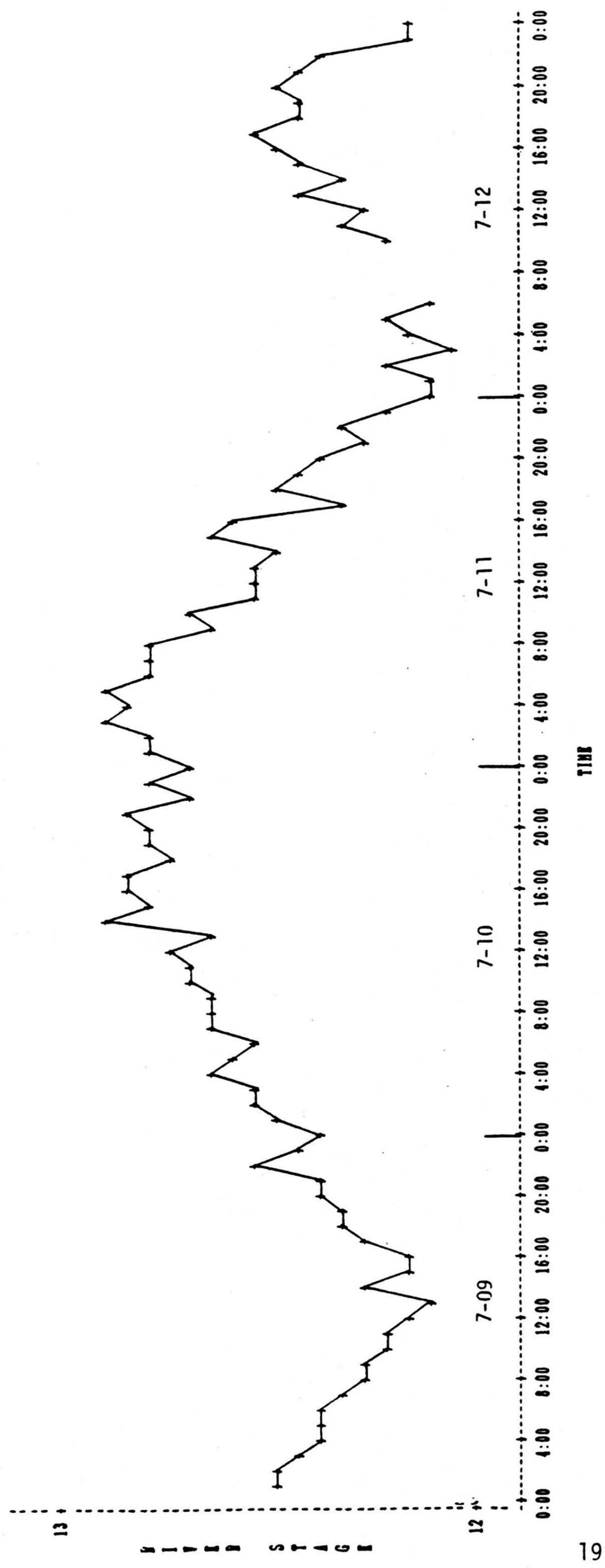


concentration in the upper edge of the backwater area was 0. 08 mg/L, ranged from 0.21 to 0.26 mg/L in the mid-reach of the backwater, and decreased to 0.13 mg/L at mile 1.5 and to 0.06 mg/L near the Ohio River. The U. S. EPA recommends a value not to exceed 0.10 mg/L in free flowing streams to prevent nuisance algal growths. No nuisance algal growth was observed during this study. This data indicates that most of the phosphorous is used by algae and/or settles to the bottom within Harrods Creek and a relatively small amount flows into the Ohio River. The utilization by algae was occurring primarily in the upper 5 feet, as evidenced by the dissolved oxygen profile data.

The field observations of hydrologic conditions also indicate that most of the wastewater effluents entering the backwater area during stable, low flow conditions travel very slowly downstream towards the Ohio River. For most of the study, the backwater area of Harrods Creek was apparently stagnant, with no visible or measurable velocity. At an incoming flow of about 3 cfs, a width of 60 feet and a depth of 10 feet, a calculated average velocity of only 0.01 feet per second would occur. At lower inf lows, such as those measured by the USGS in 1937, velocity would be even less. Surprisingly, twice during this study water was observed to be flowing upstream for a brief period of time, and three times was visibly flowing downstream. Several events might cause these observations. Conversation with the Corps of Engineers indicates the Ohio River experiences some flow perturbations occurring between the high lift dams as gates are raised or lowered, which could'also affect backwater tributary streams. Barge passage in the Ohio River might cause an upstream surge; however, no physical wave action was associated with the upstream flow. An increase in the level of the Ohio River might also cause water to back up into tributary streams. Downstream flow might be caused by a decrease in the level of the Ohio River, allowing water to move downstream. Hourly stage levels of the Ohio River at McAlpine Dam were obtained 'from the USGS and plotted (Figure 7). Stage levels are somewhat erratic, but show an overall increase on July 10, and a decrease on July II. A comparison of field notes to this stage data indicated that the Ohio River was falling during all three observations of visible downstream flow, and was rising during one upstream flow observation. The time of day of the other upstream flow event was not recorded, and thus could not be compared to stage data. The rise and fall of the Ohio River during these events was only 0.1 to 0.2 feet, and may or may not be the actual cause of the observations in Harrods Creek.

As noted, both the hydrologic observations and the phosphorous data indicate that wastewater effluents are primarily consumed within the backwater area during stable,

FIG. 7. OHIO RIVER STAGE DURING HARRODS CK STUDY
(MEASURED HOURLY ON JULY 09 THRU 12 1990)



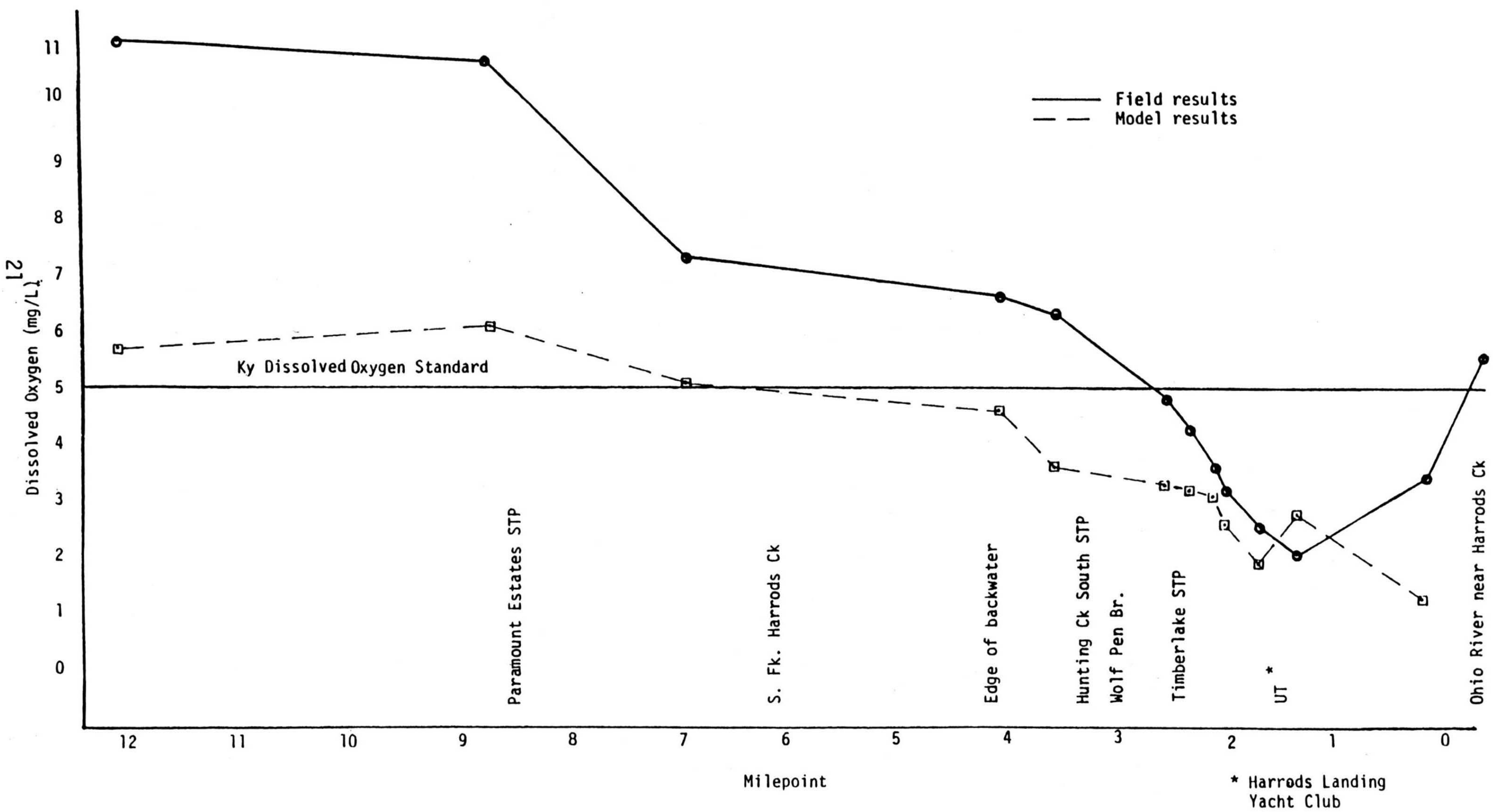
low-flow conditions. These effluents, even though of high quality, apparently overwhelm the assimilative capacity of the backwater area and are most likely the cause of the low dissolved oxygen concentrations measured in Harrods Creek.

Comparison of Field Results to Water Quality Model Results

Water quality modeling using U.S. EPA approved methodology is commonly employed by regulatory agencies throughout the United States to make permit decisions and set effluent limits for wastewater facilities. In October, 1988, updated information provided by the USGS was incorporated into the QUAL2E water quality model to simulate conditions in Harrods Creek during critical low-flow periods. One objective of the field study was to evaluate the reliability of using model results to make permit decisions in Harrods Creek.

Predicted dissolved oxygen concentrations from this modeling were plotted with the field concentrations measured during this study to assess model accuracy (Figure 8). There are two major differences between model input data versus measured field data, yet the results, especially in the backwater area, are very similar. Model predictions are based on input data that assumes low-flow conditions equivalent to the 7-day, once in 10 year (7QIO) occurrence interval, and wastewater facilities are assumed operating at design flow with effluent concentrations at the full level allowed by their permits. Actual field conditions measured during this study were significantly different. Measured streamf low into the study area was about twice that used for modeling, which is based on the USGS data collected in 1987. As previously noted, wastewater facilities are currently operating at much less than design flow, and thus have a higher quality ef fluent than required by permit limits. With these dif f erences, predicted DO concentrations from modeling would be expected to be lower than field measurements. This is precisely what has occurred and depicted on Figure 8. The pattern of change between model predictions and stream measurements are closely matched. The differences in predicted versus measured concentrations in the upper watershed are caused by photosynthesis occurring during the daylight hours when the field samples were collected, which is not accounted for in the model, and the large difference in the Paramont Estates wastewater facility's modeled design conditions versus its small actual contribution. As this fairly new development grows, its actual discharge is expected to approach design conditions. The difference in the plot pattern near the Ohio River is most likely the result of some mixing with Ohio River water, an effect that modeling does not consider.

Fig. 8. Comparison of Field Results to Model Results



Field hydrologic conditions measured from this study were next used as input parameters to the model in order to compare these predictions to measured values. Model results indicate DO violations in the backwater area, but predicted violations are not as severe as measured violations. The pattern of change again remained similar, however.

Based on this analysis, water quality modeling appears to be a reasonable tool for predicting dissolved oxygen dynamics during low-flow conditions. Modeling indicates that Harrods Creek will likely violate dissolved oxygen standards to a greater degree than what is currently occurring when approved wastewater facility expansions are completed and additional flow from developments currently under construction are realized.

Conclusions and Recommendations

Water quality data collected for this study and data collected by MSD and the USGS demonstrate that nearly 3 miles of lower Harrods Creek do not meet Kentucky's standard for dissolved oxygen. Water quality modeling indicates conditions will likely deteriorate further when streamflow conditions are lower than measured during this study and as wastewater facilities expand to their design capacities.

The Division of Water in the past few years has allowed expansion of several wastewater facilities in the lower basin, with the restriction of greatly reduced permit limits. The assumption was that expanded facilities, with more strict effluent requirements, would result in a net reduction of pollutant loads into the basin. Data collected for this study show this assumption is incorrect. Existing effluent concentrations are of much higher quality than expected, yet Harrods Creek continues to violate the DO standard. Expanded facilities will not be able to produce a better effluent than is currently discharged, thus loadings will increase, not decrease as earlier anticipated.

Areas of extensive backwater, such as Harrods Creek, do not assimilate wastewater as does a flowing stream. Elimination of wastewater discharges into lower Harrods Creek is essential if Harrods Creek is to meet water quality standards. The Division recommends implementation of MSD's North County Action Plan, which would extend sewer lines into the basin and eliminate the Hunting Creek South, Timberlake, Hunting Creek North, Ken Karla and Shadow Wood wastewater facilities. It is also recommended the plan boundaries be extended to include the Paramont Estates, Countryside Estates, and Covered Bridge facilities. Sewer lines should also be extended from MSD's Hite Creek facility to serve the Crestwood area, thus eliminating 11 existing facilities above Sleepy Hollow Lake. Effluent from Hite Creek travels over 5 miles before reaching the backwater area of Harrods Creek, and is considered beneficial because it is providing a steady inflow of high quality water.

Construction of new facilities or expansion of existing facilities in areas not meeting water quality standards cannot be approved, as required by Kentucky water quality regulations. The Division will therefore continue to deny proposals for new or expanded facilities that would negatively affect the quality of water in lower Harrods Creek.

References

(1) Buchanon, T.J., and Somers, W.P. Techniques of Water-Resources Investigations; Discharge Measurements at Gaging Stations, USCS TWRI Book 3, Chapter A-8, 1976.

(2) Bowie, G.L., W.B. Mills, D.B. Poreella, C.L. Campbell, J.R.Pagenkopt, G.L. Rupp, K. M. Johnson, P.W.H. Chan, and S.A. Gherini, Rates, Constants and Kinetics Formulations in Surface Water Quality Modelin, 2nd ed., EPA/600/3-85/040, U.S. Environmental Protection Agency, Athens, GA, 1985.

(3) Brown, L.C. and T.O. Barnwell, Jr., The Enhanced Stream WaterQuality Models QUAL2E and QUAL2E-UNCAS: Documentation and User Manual, EPA/600/3- 87/007, U.S. Environmental Protection Agency, Athens, GA, 1987.

(4) Driscoll, E.D. (E.D. Driscoll & Assoc., Inc.), J.L. Mancini(Mancini and DiToro Consulting Inc.), and P.A. Mangarella (Woodward - Clyde Consultants), Technical Guidance Manual for Performing Wasteload Allocations, Book 11, Chapters I & 2, .EPA-440/4-84-020, U.S. Environmental Protection Agency, 1983.

(5) Mills, W.B., G.L. Bowie, T.M. Grieb and K.M. Johnson (TetraTech.,. Inc.), and R.C. Whittemore (NCASI), Stream Sampling for Wasteload Allocation Applications, EPA/625/6-86/013, U.S. Environmental Protection Agency, 1986.